REMARKS

Reconsideration of this application, as amended, is respectfully requested.

THE DRAWINGS

Fig. 5 has been amended as indicated in red on the accompanying copy thereof to be labeled as --PRIOR ART--, as required by the Examiner.

Submitted herewith is a corrected sheet of formal drawing for Fig. 5 which incorporates the amendment, along with new sheets of formal drawing for Figs. 1-4, 6 and 7 which overcome the objections of the Official Draftsperson. Also submitted herewith is a Letter to the Official Draftsperson requesting approval of the new sheets of formal drawing.

THE SPECIFICATION

The specification has been amended to correct minor informalities of which the undersigned has become aware, including the informality pointed out by the Examiner. No new matter has been added, and it is respectfully requested that the amendments to the specification be approved and entered.

THE CLAIMS

Claim 1 has been amended to incorporate the subject matter of claim 2, and to recite that the connector is the first

connector on the optical path extending from the laser light emitting device.

In addition, claims 2 and 3 have been canceled, without prejudice, and new claims 4-10 have been added to recite further features of the present invention disclosed in the specification. In particular, it is noted that: new claim 4 is supported by the disclosure in the specification at page 5, lines 31-33; new claim 5 is supported by the disclosure in the specification at page 9, lines 26-30; new claims 6-8 are supported by the disclosure in the specification at page 6, lines 29-30 (see also, page 3, lines 5-6); new claim 9 is supported by the disclosure in the specification at page 1, lines 23-25 and page 3, lines 8-11; and new claim 10 is supported by the disclosure in the specification at page 6, lines 30-33.

It is respectfully submitted that no new matter has been added, and it is respectfully requested that the amendments to the claims be approved and entered.

THE PRIOR ART REJECTION

Claims 1-3 were rejected under 35 USC 103 as being obvious in view of the combination of Hamakawa et al ("Characteristics of Modulation Distortion of Fiber-Grating External-Cavity-Laser") and Pan et al (USP 5,892,781). This rejection, however, is respectfully traversed with respect to amended claim 1 and new claims 4-10.

According to the present invention as recited in amended claim 1, the FBG section is provided on the optical path between the laser light emitting device and the (first) connector, and the intercepting means is provided on the optical path between the FBG section and the (first) connector. This arrangement prevents light from returning from the connector through the FBG section toward the external cavity formed between a reflection surface of the laser light emitting device and the FBG section, thereby reducing the relative intensity of noise (RIN). And it is respectfully submitted that this structure is not disclosed, taught or suggested by the combination of Hamakawa et al and Pan et al cited by the Examiner.

In particular, it is pointed out that as recognized by the Examiner, Hamakawa et al does not disclose an intercepting means. In addition, it is pointed out that although Pan et al does disclose an isolator, this reference does not indicate any placement relationship between a connector and an isolator and this reference fails to disclose, teach or suggest a RIN reduction effect achieved by the prevention of return light from a connector, as in the manner of the claimed present invention.

Still further, it is pointed out that in Pan et al the cavity is formed between FBG sections (11A and 11B), and that a semiconductor laser device (laser light emitting device) is employed as the excitation light source. And it is respectfully submitted that this structure disclosed in Pan et al does not at all suggest forming part of an external cavity by means of a

laser light emitting device as according to the structure of the present invention as recited in amended claim 1.

Accordingly, it is respectfully submitted that even if the teachings of Pan et al and Hamakawa et al were combinable in the manner suggested by the Examiner, the above described structural features and advantageous effects of the present invention as recited in amended claim 1 would still not be achieved or rendered obvious.

It is therefore respectfully submitted that the present invention as recited in amended claim 1 and each of claims 4-10 depending therefrom patentably distinguishes over the combination of Hamakawa et al and Pan et al under 35 USC 103.

INFORMATION DISCLOSURE STATEMENT

Submitted herewith is a copy of USP 5,699,377 to Pan identified on the attached Patent Office form PTO-1449.

This reference discloses providing an FBG section on an optical path at a position facing an isolator with respect to a laser light emitting device. However, this reference fails to disclose an arrangement having an FBG section provided between a laser light emitting device and a connector and having an isolator provided between the FBG section and the connector. Indeed, no connector is even illustrated or disclosed in this reference.

Accordingly, it is respectfully submitted that this reference fails to disclose, teach or suggest preventing an

increased RIN caused by return light from a connector to a laser light emitting device through an FBG section, as according to the structure of the present invention as recited in amended claim 1. And it is respectfully submitted that the present invention as recited in amended claim 1 and claims 4-10 depending therefrom also patentably distinguishes over this reference, taken singly or in combination with any of the other prior art references of record, under 35 USC 102 as well as under 35 USC 103.

It is respectfully requested that the Examiner consider USP 5,699,377 and make this publication of record, and it is further requested that the Examiner return an initialed copy of the attached Form PTO-1449 to confirm that this publication has been made of record.

As required by 37 CFR 1.97(c), submitted herewith is a check in the amount of $180 to cover the Patent Office Fee required under 37 CFR 1.17(p) in connection with the consideration of this Information Disclosure Statement at this stage of prosecution.

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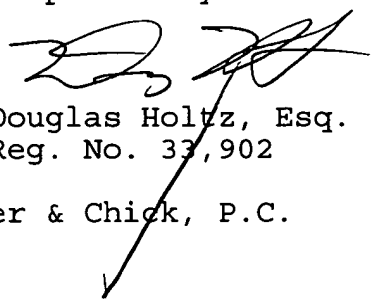
In view of the foregoing, entry of the amendment, allowance of the claims, and the passing of the application to issue are respectfully solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,



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EXTERNAL CAVITY LASER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an external cavity laser capable of oscillating a laser beam having a given oscillation wavelength by means of an optical fiber having the Bragg wavelength of light reflected by a grating adjusted to a given wavelength, i.e., a fiber Bragg grating (hereinafter referred to as "FBG").

Description of the Related Art

Conventionally, some lasers of this type, such as the one described in U.S. Pat. No. 4,786,132, oscillates a single-wavelength laser beam with use of an FBG in an external cavity. One such laser appears in OECC '96 (First Optoelectronics and Communications Conference Technical Digest, July 1996, Makuhari Messe), 18P-18. This laser, using the FBG in its external cavity, has a so-called lensed-fiber arrangement such that an end facet of a fiber, which is an optical junction to a laser source, is lensed.

According to this laser, the transmission quality of transmitted signals is evaluated by the signal-to-noise ratio characteristic. In the case of picture transmission, for example, the relative intensity of noise (RIN) is adjusted to -130 dB/Hz or more. Thereupon, the inventors hereof conducted an experiment in which signals were transmitted under the following conditions using an apparatus model that is constructed in the same manner as the prior art example described in OECC '96, as shown in FIG. 5.

This apparatus is a laser that has a multi quantum well structure, for example. The laser comprises a laser light emitting device 10 formed of a laser diode, for use

as a light source, and an FBG section 20, a light guide, which is a narrow-band reflector-type optical fiber having its reflection-peak wavelength adjusted to th Bragg wavelength. In this arrangement, the las r light emitting device 10 includes [has] an active layer (not shown) and antireflection and high-reflection surfaces 11 and 12 formed on either side of the active layer. On the other hand, the FBG section 20 includes a lensed fiber having [one] a first end facet 21 lensed in the shape of a hemi-spherical surface, a grating 22 formed in the fiber core, and [the] a [other] second end facet small-diameter portion 23 of a cladding that is connected with a connector 30. In the laser constructed in this manner, light is generated in the active layer by injected current, and it is reflected by an external cavity, which is formed between the high-reflection surface 12 and the grating 22, and is delivered as a laser beam from the [other] second end facet small-diameter portion 23 through the connector 30.

Parameters for the laser with this arrangement were set as follows. In the laser light emitting device 10, the field reflectance of the antireflection surface 11 was set at 10^{-4} or less, and the length from the antireflection surface 11 to the high-reflection surface 12 was adjusted to 600 μm or less. In the FBG section 20, the field reflectance and the full [with] width at half maximum for the Bragg wavelength were set at 0.4 or less and 0.1 mm, respectively. The [one] first end facet 21 was subjected to antireflection coating, its field reflectance was set at 0.4 or less, and the optical coupling factor was adjusted to 0.5.

FIG. 6 is a characteristic diagram showing a noise characteristic as the result of this experiment. Based on this result, the inventors hereof confirmed that the level of noises produced by connector connection, that is, the

intensity level of reflected return light that returns from the connector toward the laser, would inevitably influence the transmission band. Thereupon, the inventors hereof obtained the relative intensities of nois s for the cases where a physical connector (PC), superphysical connector (SPC), angled physical connector (APC) were connected individually to the [other] second facet 23 of the cladding. FIG. 7 is a diagram showing the results. For the cases "NO ISOLATOR" shown in FIG. 7, the relative intensities of noises exceeded -130 dB/Hz without regard to the connector type. In carrying out picture transmission in this state, the screen would inevitably suffer noises, thus resulting in lowered picture transmission quality.

SUMMARY OF THE INVENTION

The present invention has been contrived in consideration of these circumstances, and its object is to provide an external cavity laser capable of obtaining satisfactory transmission quality at all times without regard to a connector or connectors to be connected.

In order to achieve the above object, in an external cavity laser according to the present invention, an FBG section is formed having the Bragg wavelength of light reflected by a grating adjusted to a given wavelength. A laser light emitting device having a reflective surface, which generates light, is optically coupled to the FBG section to ensure input and output of light. The generated light is reflected by the reflective surface. A cavity is formed including the reflective surface of the laser light emitting device and the grating. The cavity resonates the light between the reflective surface and the grating, thereby oscillating a laser beam having a given oscillation wavelength through the connector. Further, intercepting

VERSION OF CLAIMS SHOWING AMENDMENTS MADE

Claim 1 has been amended as follows:

1. (Amended) An external cavity laser for oscillating laser light through a connector, comprising:

a fiber Bragg grating section formed of an optical fiber having [the] a Bragg wavelength of light reflected by a grating adjusted to a given wavelength;

a laser light emitting device [designed to generate] that generates light, and that is optically coupled to the fiber Bragg grating section to ensure input and output of the light, [and] said laser light emitting device including a reflective surface for reflecting the generated light;

a cavity [formed including] that is formed between the laser light emitting device and the grating, and [designed to resonate] that resonates the light between the reflective surface of the laser light emitting device and the grating, thereby oscillating a laser beam having a given oscillation wavelength;

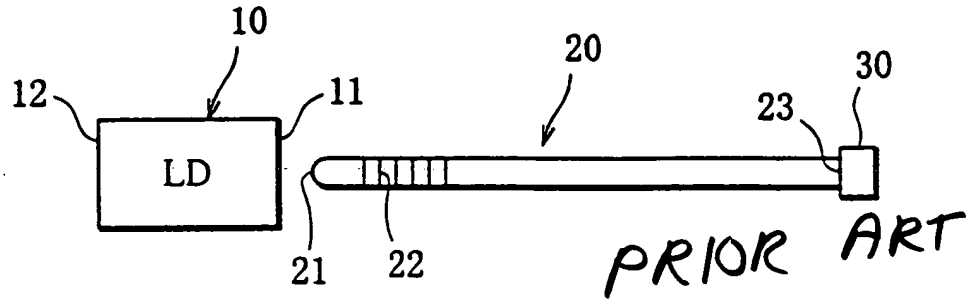
a connector [for outputting] that outputs the light [emitted from] oscillated by the cavity, said connector being a first connector provided on an optical path extending from the laser light emitting device; and

intercepting means for intercepting reflected waves from the connector; [,]

wherein the fiber Bragg grating section is located on the optical path between the laser light emitting device and the connector; and

wherein the intercepting means [being] is located on [an] the optical path between the [cavity] the fiber Bragg grating section and the connector.

FIG. 5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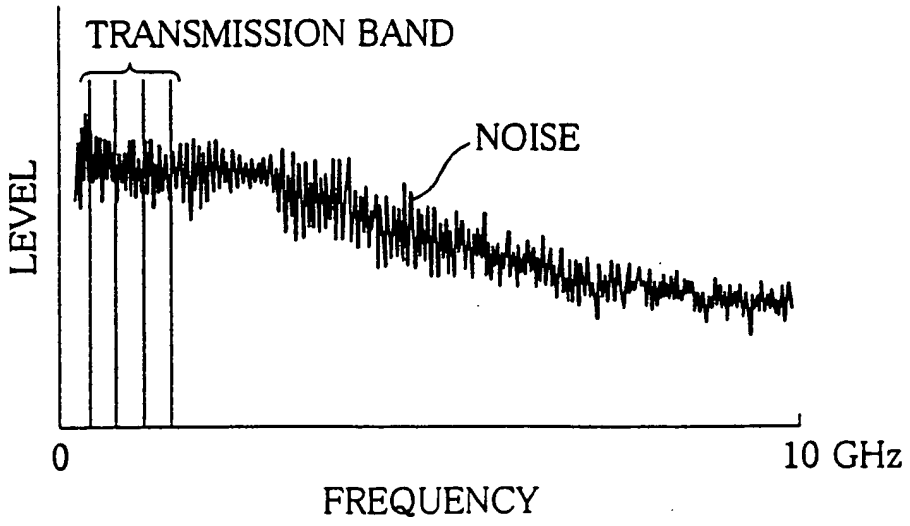
PRIOR ART

FIG. 6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NOISE
LEVEL
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